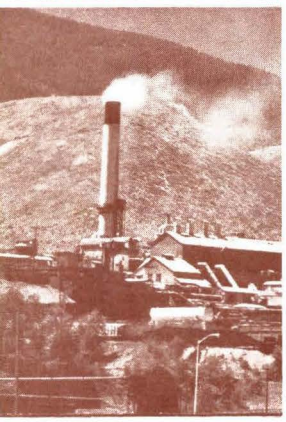
SB 761
U7N6
#75-7



FOREST ENVIRONMENTAL PROTECTION

USDA · FOREST SERVICE · NORTHERN REGION
State & Private Forestry · Missoula, MT 59801

Report No. 75-7

5200
March 1975

STATUS OF MOUNTAIN PINE BEETLE INFESTATIONS, SOLO JOE AND BEAVER CREEK DRAINAGES, YAAK DISTRICT, KOOTENAI NATIONAL FOREST, MONTANA 1974

by

M. D. McGregor, D. R. Hamel, Entomologists
and R. C. Lood, H. E. Meyer, Biological Technicians

ABSTRACT

Mountain pine beetle reached epidemic levels in Solo Joe and Beaver Creek drainages in 1972. From 1972 to 1974, approximately 20,581 trees with an estimated volume loss of 2,531,913 board feet were killed in the Solo Joe area; and 6,465 trees with a volume loss of 1,007,497 board feet were killed in the Beaver Creek infestation. Based on current buildup ratios, tree diameter distributions within the stand, and phloem thickness of these trees, there is a potential of 70,000 trees being killed in 1975. Selective logging to remove infested and susceptible trees is recommended to reduce losses.

INTRODUCTION

Mature and overmature lodgepole pine, *Pinus contorta* Douglas, stands in the Solo Joe (Fig. 1) and Beaver Creek (Fig. 2) drainages, Yaak River drainage in northwestern Montana became infested by mountain pine beetle, *Dendroctonus ponderosae* Hopk., in 1972.

Aerial insect and disease detection surveys showed an annual increase in number of faders. Extremely dry climatic conditions that prevailed during 1973 and 1974 may have further predisposed trees to attack. In addition, availability of mature and overmature large diameter trees probably contributed to the population buildup.

LIBRARY
8 1976
ROCKY MOUNTAIN STATION

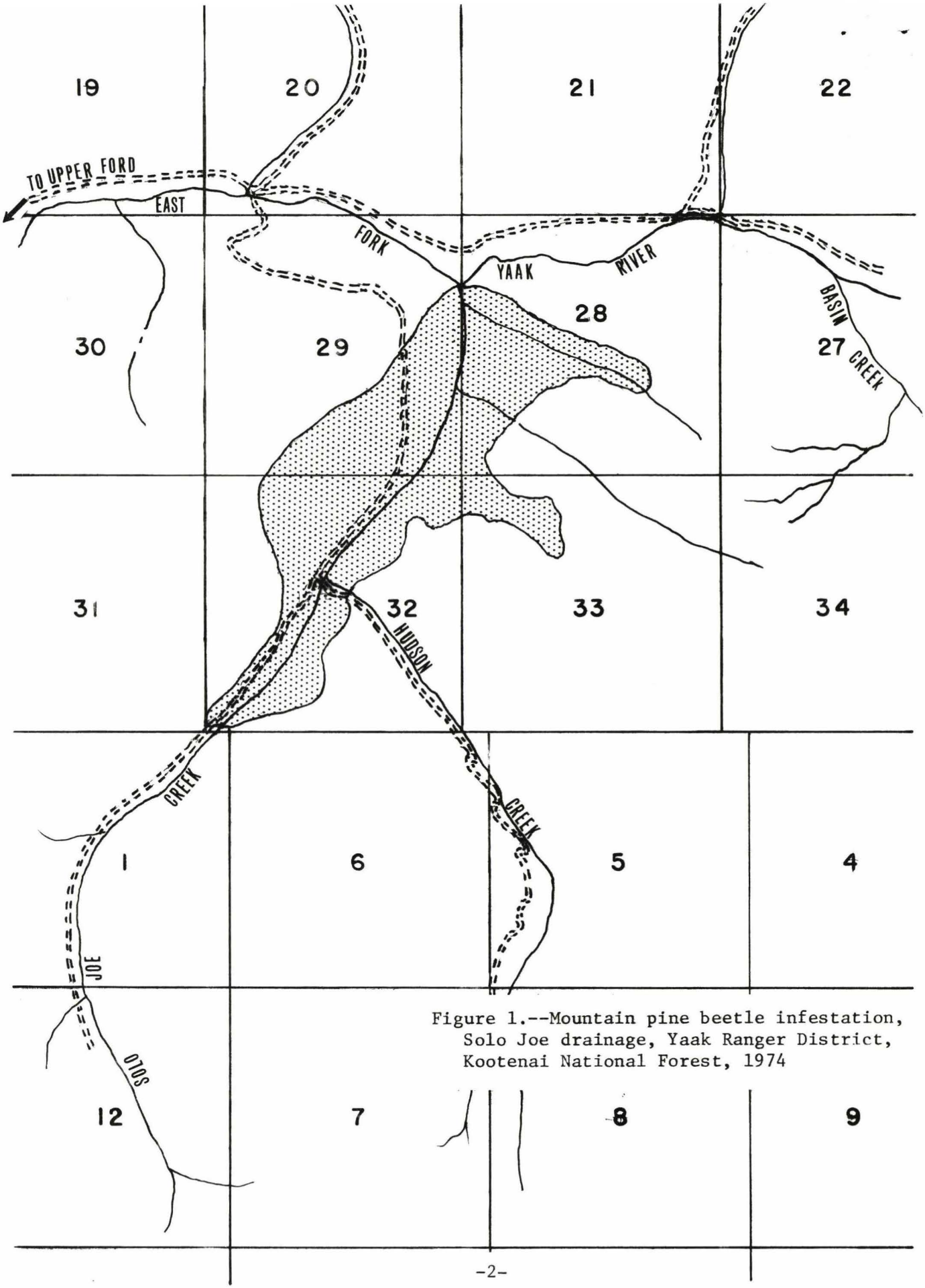


Figure 1.--Mountain pine beetle infestation, Solo Joe drainage, Yaak Ranger District, Kootenai National Forest, 1974

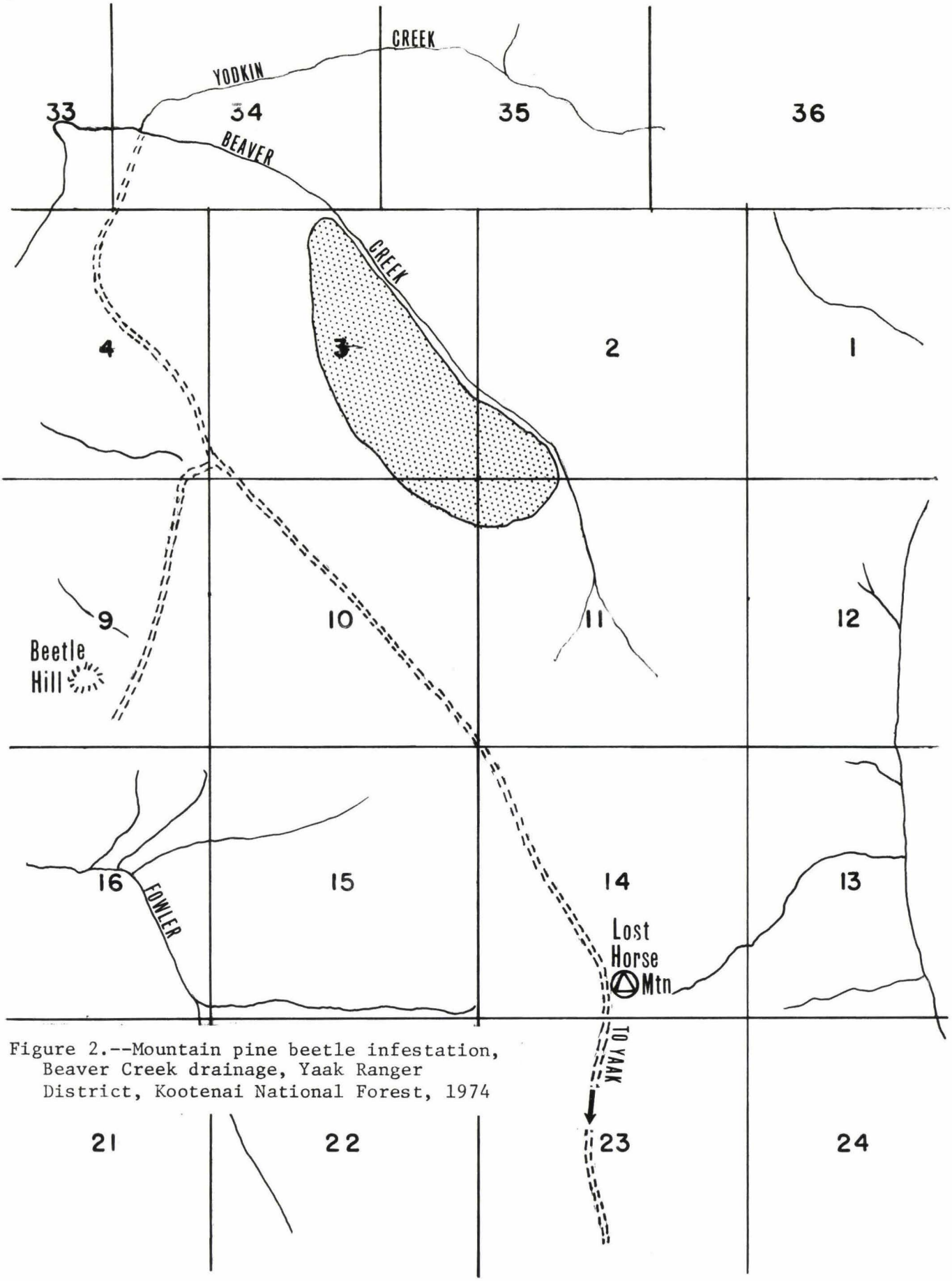


Figure 2.--Mountain pine beetle infestation, Beaver Creek drainage, Yaak Ranger District, Kootenai National Forest, 1974

Because of the increased number of recently attacked lodgepole pine observed by personnel of the Yaak District, an evaluation was requested to determine infestation boundaries, estimate tree and volume loss, and measure buildup ratios from 1972 through 1974.

METHODS

Ground surveys were conducted on 833 acres in Solo Joe and 380 acres in Beaver Creek drainage during October, November, and December 1974. Variable plots (BA=10) were established at 5-chain intervals on lines 5 chains apart. Spiegal Relaskops were used to tally trees in each plot. All trees tallied were recorded by species, measured by diameter at breast height (d.b.h.) and total height for volume estimates; each tree was classified into one of the following categories:

0 - green, uninfested.
1 - 1974 attack; pitchtubes, brood and blue stain present.
2 - 1973 attack; faded foliage, pitchtubes, blue stain, emergence holes evident.
3 - 1972 attack; majority of needles dropped.
4 - unsuccessfully attacked trees; pitchtubes present, green foliage.

In addition, twenty 1/10-acre plots were taken on a systematic grid pattern at 5-chain intervals to obtain a stand profile of phloem thickness for each diameter class.

At each plot, a clinometer was used to determine if trees fell within the plot boundary; and two phloem samples were removed from opposite sides of two trees, 5 inches d.b.h. and larger in each diameter class. Phloem samples were measured to the nearest 1/100 of an inch with a steel ruler.

Survey data were analyzed using a modified R-1 timber sale cruise program.

RESULTS

Stand description.--Habitat type in the Solo Joe area is *Abies lasiocarpa/Clintonia uniflora* at higher elevations, and *Tsuga heterophylla/Clintonia uniflora* at lower elevations along creek bottoms. Stand composition is lodgepole pine, *Pinus contorta* Dougl., 43.8%; Engelmann spruce, *Picea engelmanni* Parry, 13.2%; western larch, *Larix occidentalis* Nutt., 24.8%. Subalpine fir, *Abies lasiocarpa* (Hopk.) Nutt.; and Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, make up 4.0% of the stand each; with the remaining 3.1% including western hemlock, *Tsuga heterophylla* (Raf.) Sarg.; western white pine, *Pinus monticola* Douglas; and grand fir, *Abies grandis* (Dougl.) Lindl.

Habitat type in the Beaver Creek infestations is *Tsuga heterophylla/ Clintonia uniflora*. Stand composition is lodgepole pine, 30.2%; subalpine fir, 26.1%; western larch, 16.8%; Engelmann spruce, 13.2%; western redcedar, *Thuja plicata* Dunn., 6.6%; Douglas-fir, 4.1%; with 2.5% western hemlock, and 2.4% western white pine.

Intensity of infestation.--The Solo Joe infestation decreased from 7,091 infested trees in 1972 to 1,941 trees in 1973, then increased to 11,549 trees in 1974 (Table 1). This shows a 1:0.2 ratio of old to newly attacked trees from 1972 to 1973, and a 1:5.9 buildup ratio of old to newly attacked trees from 1973 to 1974. A total of 20,581 trees with an estimated volume loss of 2,531,913 board feet has occurred during the 3-year period 1972 to 1974. Infested trees averaged 11.0 inches d.b.h. each year, and ranged from 5 to 21 inches d.b.h. in 1972; 6 to 18 inches d.b.h. in 1973; and 6 to 22 inches d.b.h. in 1974.

Table 1.--Tree and volume loss estimates caused by the mountain pine beetle, Solo Joe drainage, Yaak District, Kootenai National Forest, 1972-1974.

Year	Number lodgepole pine killed			Volume loss (board feet)	
	Av. d.b.h.	Per acre	Total	Per acre	Total
1972	11.0	8.5	7,091	713	593,937
1973	11.0	2.3	1,941	311	258,721
1974	11.0	13.9	11,549	2,016	1,679,255
Total or Average	11.0	8.2	20,581	1,013	2,531,913

In 1972, 55.7% of the trees killed were 12 inches d.b.h. and larger; 62.5% were 12 inches d.b.h. and larger in 1973; and 68.1% were 12 inches d.b.h. and larger in 1974 (Table 2).

Table 2.--Number and percent of infested trees by diameter class, Solo Joe drainage, Yaak District, Kootenai National Forest, 1972-1974.

Year	D.b.h. size class (inches)														
	5	6	7	8	9	10	11	12	13	14	15	16	17	18+	Total
1972	2	0	2	8	11	21	12	25	19	15	12	6	2	6	141
%	1.4	0	1.4	5.6	7.8	14.8	8.5	17.7	13.4	10.6	8.5	4.2	1.4	4.2	
1973	0	1	0	3	2	5	1	5	2	5	2	3	0	3	32
%	0	3.1	0	9.3	6.2	15.6	3.1	15.6	6.2	15.6	6.2	9.3	0	9.3	
1974	0	1	5	5	8	17	23	18	25	25	18	15	4	4	168
%	0	.5	2.9	2.9	4.7	10.1	13.6	10.7	14.8	14.8	10.7	8.9	2.3	2.3	

Twenty-nine percent of the residual green stand is 12 inches d.b.h. and larger.

The Beaver Creek infestation increased from 1,777 infested trees in 1972 to 2,730 infested trees in 1973, then decreased to 1,958 trees in 1974. This shows a 1:1.6 buildup ratio of old to newly attacked trees from 1972 to 1973, and 1:0.7 ratio from 1973 to 1974 (Table 3).

Table 3.--Tree and volume loss estimates caused by the mountain pine beetle, Beaver Creek drainage, 1972-1974.

Year	Number of lodgepole pine killed			Volume loss (board feet)	
	Average d.b.h.	Per acre	Total	Per acre	Total
1972	12.0	4.7	1,777	492	187,069
1973	13.0	7.2	2,730	1,084	411,870
1974	13.0	5.2	1,958	1,075	408,558
Total or Average	12.6	5.7	6,465	883	1,007,497

In 1972, 80% of all trees killed were 12 inches d.b.h. and larger. In 1973, 85% of the lodgepole pine killed were 12 inches d.b.h. and larger, and 96% of the trees killed in 1974 were 12 inches d.b.h. and larger (Table 4).

Table 4.--Percent of lodgepole pine mortality by diameter class, Beaver Creek drainage, Kootenai National Forest, 1972-74

Year	D.b.h. class (inches)											
	7	8	9	10	11	12	13	14	15	16	17	18+
1972 %	2.8	0	2.8	5.7	8.5	14.2	17.1	22.8	17.1	8.5	0	0
1973 %	2.5	2.5	2.5	0	7.5	10.0	12.5	15.0	12.5	12.5	20.0	2.5
1974 %	0	4.1	0	0	4.1	8.3	20.8	25.0	8.3	4.1	20.8	8.3

In the residual green stand, 30.6% of the lodgepole pine are 12 inches d.b.h. and larger.

Phloem ranged from 0.03 to 0.12 inch thick in trees measured. Of all trees measured during 1974, 42% were 12 inches d.b.h. and larger, and 2.6% had a phloem greater than or equal to 0.11 inch thick. Phloem measurement data collected in the Solo Joe stand is shown in Table 5.

Table 5.--Summary of phloem measurement of lodgepole pine, Solo Joe mountain pine beetle infestation, 1974

D.b.h.	Mean	Standard deviation	Standard error
5	0.030	--	--
6	.048	0.010	0.006
7	.055	.022	.007
8	.054	.012	.004
9	.062	.016	.004
10	.066	.018	.004
11	.068	.015	.004
12	.064	.016	.004
13	.071	.016	.005
14	.078	.015	.005
15	.095	.007	.005
16	.103	.015	.009

DISCUSSION

Infestations of mountain pine beetle usually develop in stands 80 years and older containing many trees 10 inches d.b.h. and larger. In such stands, depletion increases 4 to 9% with each inch increase in tree diameter above 6 inches d.b.h. (Safranyik et al., 1974). Outbreaks usually continue until the large diameter component of the stand is killed; consequently, average diameter of the residual stand is usually below 8 inches d.b.h.

The Solo Joe infestation increased from 7,091 infested trees in 1972 to 11,549 infested trees in 1974. Infested trees per acre averaged 8.5 in 1972 and increased to 13.9 in 1974. Approximately 20,581 trees were killed with an estimated volume loss of 2,531,913 board feet during the 3-year period 1972-74.

In the Beaver Creek infestation, approximately 6,465 trees were killed with an estimated volume loss of 1,007,497 board feet during the 3-year period 1972-74. In 1974, buildup ratios of old to newly attacked trees were 1:5.1 in the Solo Joe infestation, and 1:0.7 in the Beaver Creek area.

Number of trees killed during mountain pine beetle outbreaks is dependent on population density which is influenced by: (1) phloem thickness, (2) tree diameter, (3) stand density, and (4) habitat type (Cole, 1973; Safranyik et al., 1974). Mountain pine beetle prefers larger diameter trees each year as well as over the life of an infestation (Gibson, 1943; Hopping and Beall, 1948; Cole and Amman, 1969). Reid (1963) observed that beetle survival increased with tree diameter. Our data shows that as this infestation progressed, *D. ponderosae* progressively killed more trees 12 inches d.b.h. and larger yearly. In the Solo Joe infestation, the number of trees 12 inches d.b.h. and larger killed increased from about 5.6% in 1972 to 68.0% in 1974. In the Beaver Creek infestation, the number of trees 12 inches d.b.h. and larger that were killed increased from 80% in 1972 to about 96% in 1974.

Amman (1969) concluded from his studies that phloem thickness is the principal factor regulating brood production of *D. ponderosae* in lodgepole pine stands when optimum conditions are favorable for beetle development. Also, brood production is positively correlated with phloem thickness and phloem thickness is positively correlated with tree diameter (Amman 1969, 1972). Cole and Cahill (In press) concluded from studies in Colorado that the correlation of phloem thickness over diameter becomes an effective measurement for evaluating infestation potential in a stand.

Samples collected from the Solo Joe infestation show 26% of the trees 12 inches in diameter and larger had phloem greater than or equal to 0.11 inch thick. By selectively cutting all trees 12 inches d.b.h. and larger we would remove 57.1% of the susceptible host component of the stand. If trees 10 inches d.b.h. and larger with phloem equal to or greater than 0.11 inch thick were included in the cut, 85.9% of the susceptible host component would be removed.

By dropping the selective cut to include trees 9 inches d.b.h. and larger, we increase the selective cut to include 38% of the trees with 0.11 inch thick phloem; the susceptible component in the stand would be reduced 100%. Since no trees smaller than 9 inches d.b.h. had phloem greater than or equal to 0.11 inch thick, it would not be necessary to mark any trees smaller than 9 inches d.b.h. in a selective cutting.

Based on buildup ratios from 1972 to 1974, and on the formula

$Y^1 = y+bx$ (Baker, 1968) where

Y^1 = the potential cumulative number of trees killed predicted through next year (1975)

y = the cumulative number of trees killed through this year (1974)

x = number of trees killed this year (1974)

x_1 = number of trees killed last year (1973)

$b = \frac{x}{x_1}$

it is predicted that through 1975, 89,297 trees will be killed, of which 70,000 could be killed in 1975. The predicted number of trees that would be killed through 1974 was 9,032; actual was 11,549, a difference of 1,993 trees. In the Beaver Creek infestation, the formula predicts that 1,370 trees would be killed in 1975, bringing the cumulative number of trees killed to 7,835. It was predicted that 8,604 trees would be killed through 1974; actual was 7,835, a difference of 769 trees. As logging or beetles remove susceptible trees--those with 0.11 inch thick phloem and greater--from the stand, the outbreak should begin to decline. Based on diameter distribution within these stands, sufficient large diameter lodgepole pine exist to maintain epidemic levels in both areas for several years.

Approximately 44% of the stand in Solo Joe and 30% in Beaver Creek are lodgepole pine. It is possible that a mixed tree species of this amount could alter the course of these infestations, particularly in the Beaver Creek infestation. Amman and Baker (1972) concluded from their studies that the proportion of other tree species would have to be considerably more than 36% in the elevational zone of optimal beetle development for lodgepole pine in a mixed species forest to be less susceptible to mountain pine beetle damage. Flint (1924) and Roe and Amman (1970) found no difference in susceptibility of lodgepole pine in mixed than in pure stands to mountain pine beetle attacks. Because of the number of large diameter lodgepole pine within each infested area, we do not believe the amount of mixed species complex will alter the epidemic status of either infestation.

RECOMMENDATIONS

Management alternatives available for mountain pine beetle suppression are:

1. Do nothing.

2. Chemical control. Cut and treat infested trees with ethylene dibromide 56% concentrate and one part of solution to 19 parts diesel oil. Or use lindane, generally obtained as a 20% emulsifiable concentrate mixed with fuel oil in a ratio of one part concentrate to 14 parts oil.

3. Silvicultural practices.

    a. Fell and burn infested trees
    b. Salvage log infested trees
    c. Selectively log to remove infested trees and those trees 9 inches d.b.h. and larger, and those with phloem equal to or greater than 0.11 inch thick.

Applied suppression (chemical or felling and burning) is not recommended for either infestation. Both methods have had limited success in some outbreaks, but they tend to serve only as a holding actions and do not

reduce infestations to endemic status, or lessen stand susceptibility. Amman and Baker (1972) found that beetle populations declined in approximately the same number of years in both treated and untreated stands.

Salvage logging only infested trees will not alter susceptibility of the stand to beetle attack. Indications are that by logging infested and beetle generator trees (i.e., trees 9.0 inches and greater d.b.h. having 0.11 inch phloem), stand structure should be altered sufficiently and hopefully result in a beetle population decline.

In view of the high probability of the infestation continuing at epidemic levels in these stands, it is sound policy to consider planned harvesting of the lodgepole pine when it is between 80 and 100 years old. According to Safranyik et al. (1974) the setting of rotation age and projected wood requirements should take into account the chance of mountain pine beetle infestation and the resulting severe depletion. In areas of high hazard, gains made by allowing longer rotations are probably offset by losses to the beetle. Priority cutting should be given older stands with larger diameter trees. According to Safranyik et al. (1974), harvesting should not be delayed beyond the age when current and mean annual increment are equal for a stand.

LITERATURE CITED

Amman, G. D., 1969. Mountain pine beetle emergence in relation to depth of lodgepole pine bark. USDA Forest Serv., Intermountain Forest and Range Expt. Sta. Res. Note INT-96, 8 pp.

Amman, G. D., 1972. Mountain pine beetle brood production in relation to thickness of lodgepole pine phloem. J. Econ. Entomol. 65(1): 138-140.

Amman, G. D., and B. H. Baker, 1972. Mountain pine beetle influence on lodgepole pine stand structure. Jour. For. 70(4):204-209.

Baker, B. H., 1968. The use of "Buildup Ratios" as indicators of mountain pine beetle population trends. Branch of Insect and Disease Prevention and Control. Fire Management, USDA Forest Serv., Ogden, Utah. Office Rept. 6 pp.

Cole, W. E., and G. D. Amman, 1969. Mountain pine beetle infestations in relation to lodgepole pine diameters. USDA Forest Serv., Intermountain Forest and Range Expt. Sta., Ogden, Utah. Res. Note INT-95, 7 pp.

Cole, W. E., 1973. Interaction between mountain pine beetle and dynamics of lodgepole pine stands. USDA Forest Serv., Intermountain Forest and Range Expt. Sta., Ogden, Utah. Res. Note INT-170, 6 pp.

Cole, W. E., and D. B. Cahill (In press). Predicting and controlling mountain pine beetle epidemics in lodgepole pine. USDA Forest Serv., Intermountain Forest and Range Expt. Sta., Ogden, Utah.

Flint, H. R., 1924. Various aspects of the insect problem in the lodgepole pine region. USDA Forest Serv., Dl Appl. Forestry Notes 54, 4 pp.

Gibson, A. L., 1943. Status and effect of a mountain pine beetle infestation on lodgepole pine stands. Forest Insect Lab., USDA Forest Serv., Coeur d'Alene, Idaho, 34 pp.

Hopping, G. R., and G. Beall, 1948. The relation of diameters of lodgepole pine to incidence of attack by the bark beetle, *Dendroctonus monticolae* Hopk., Forest Chron. 24:141-145.

Reid, R. W., 1963. Biology of the mountain pine beetle, *Dendroctonus monticolae* Hopk., in the east Kootenai Region of British Columbia. III. Interaction between the beetle and its host, with emphasis on brood mortality and survival. Can. Entomol. 95:225-238.

Roe, A. L., and G. D. Amman, 1970. The mountain pine beetle in lodgepole forests. USDA Forest Serv., Intermountain Forest and Range Expt. Sta., Res. Pap. INT-71, 23 pp.

Safranyik, L., D. M. Shrimpton, and H. S. Whitney, 1974. Management of lodgepole pine to reduce losses from the mountain pine beetle. Pac. Forest Res. Centre, Can. Forestry Serv., Victoria, B.C., Forestry Tech. Rept. 1.